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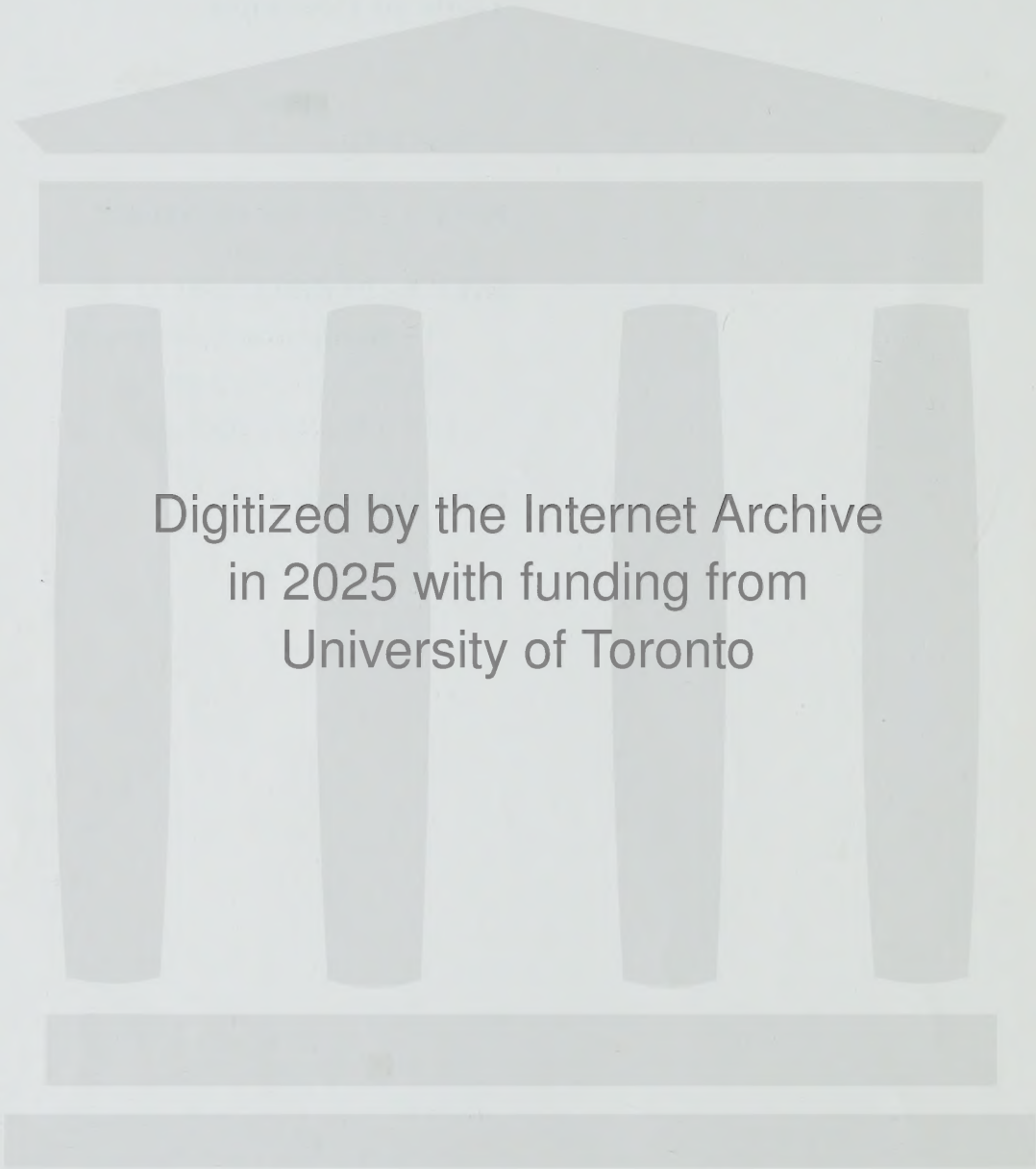
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Foreword

Creation, Life, and Death:

This course is aimed at deepening the student's insight into these fundamental questions by applying the methods of science to the study of living organisms.

The Grade 13 Biology course is an educational unit that stands alone. It is intended to provide intellectual stimulation to those nearing the end of formal education as well as to those going on to university. Both should acquire a more penetrating view of the nature of life.

Basic to this course is the axiom that science tolerates no absolutes. While receptiveness to new facts has always been the mark of the educated person, an open mind is more important than ever in the wake of advances made in science and technology in our century. At the very basis of education is the necessity of teaching students to be ready to change their ideas when new facts are presented.

New advances in science have had a particular effect on the study of biology. New knowledge gained through electron microscopy and molecular biology deepens our understanding of cell structure and function. It also means that teachers must maintain a balance between morphology and biochemistry at a level compatible with the background of their students. These advances also mean that biology students must be familiar with certain principles of chemistry and physics although they should not have to memorize a long series of chemical reactions and structural formulae.

This publication presents the teacher with broad guidelines within which there is scope for a wide variety of programs. One teacher may choose to start with the simple and work up to the complex: for instance, from atoms, molecules, and organelles in cells to the complex communities of plants and animals. Another might reverse the order by starting with familiar plants and animals, going on to a study of protoplasm and its constituents. Other equally valid approaches are possible.

This booklet suggests three possible approaches for teaching the course. The teacher is free to choose any of them or work out a new one, developing the seven basic units outlined in Part A in any sequence and depth that suit the needs and interests of his students. In some areas, even the basic units might be enriched or limited to fill the needs of a particular community. With any approach, however, the course should be based on the formulation of principles from experimental data, obtained whenever possible from the students' own laboratory investigations. A wealth of student experiences outside the laboratory is also available: field trips, films, periodicals, television programs, the school reference library, seminars, discussions, debates, or essays in which the students do their own research. In all these activities, the students' own efforts should provide the mainspring for the acquisition of knowledge.

Part A
Course of Study

The course of study summarizes the main outlines of the curriculum by providing a list of topics for study. The ideas expressed in the Foreword, when combined with this outline, will enable teachers to organize the emphasis and details of the course themselves if they want to do so.

Unit I
Characteristics of Living Things

This introductory section may be useful in setting the tone of the course and in exploiting the students' initial enthusiasm.

1. Movement
2. Irritability
3. Reproduction
4. Metabolism

Unit II
Cells

In the laboratory, isolated cell fractions carry on a variety of activities. But in nature the intact cell continues to appear to be the basic biological unit. The knowledge of gross and fine structure of cells, their energetic, communicative, and reproductive activities is an important part of modern biology, as is the experimental basis for that knowledge.

1. Structure of cells
2. Composition of protoplasm
3. Physical properties of protoplasm
4. Catabolism
5. Anabolism
6. Cell membranes
7. Mitosis

Unit III
Organisms

An observer in the natural world first encounters whole organisms as opposed to cells or tissues. The student discovers the structure of an organism by dissection to progressively finer and finer levels. He discovers how an organism works by measurement of the living processes under various experimental conditions. Perhaps the most remarkable feature of single, whole organisms is the way in which they regulate the interactions of their various functions and maintain internal constancy within relatively narrow limits.

1. Organization of tissues, organs, systems
2. Dissection and study of a mammal:
   (a) Digestion
   (b) Circulation
   (c) Mechanical respiration
   (d) Excretion
   (e) Locomotion
   (f) Reproduction
   (g) Co-ordinating systems
3. Dissection and study of a seed plant:
   (a) Supporting system
   (b) Anchorage
   (c) Absorption of materials
   (d) Conducting system
   (e) Growth
   (f) Gas exchange system
   (g) Photosynthetic system
   (h) Food storage system
   (i) Reproduction
   (j) Co-ordinating system

Unit IV
Classification of Organisms

Organisms display remarkable diversity and variation within large natural groupings that share many common

features. As our understanding of structure and function broadens to include the molecular level of living, we are better able to arrange the organisms in groups that display the basic relationships among them.

1. History of systematics
2. Principles of classification
3. Use of a taxonomic key

Unit V

Interdependence of Organisms

An organism cannot live by itself in isolation. Both cooperation and competition among organisms are necessary for survival. Organisms interact on each other in a variety of ways, and the life of every organism leaves its surroundings altered in some way. Although much of biology deals with the internal relations of organisms, this section stresses the external relations of organisms. Many of the most pressing problems facing humanity are environmental in character.

1. Photosynthesis fixes energy
2. Food chains and webs
3. Communities and succession
4. Factors affecting population size
5. Special relationships (mutualism, parasitism, etc.)
6. The influence of man in the environment

Unit VI

Heredity and Variation: Genetic Continuity

Disease, accident, predators, or aging will eventually cause the death of any organism. The continuity of germ plasm is maintained by means of reproduction, either sexual or asexual. Asexual reproduction preserves the genetic qualities of the single parent. Sexual reproduction permits genetic variation from the parents which are commonly paired.

1. Reproduction as a phenomenon
2. Meiosis and heredity

Unit VII

Evolution: Changes in Living Things Through Time

The action of environmental pressures on heritable variation results in the development of new kinds of organisms. Thus each kind of organism may have the opportunity to remain well adapted to the environment it occupies or, over long periods of time, to develop several new forms and habits suited to changed environments.

1. Darwin's theory
2. Mechanism of evolution
3. Application in improving varieties of domestic plants and animals

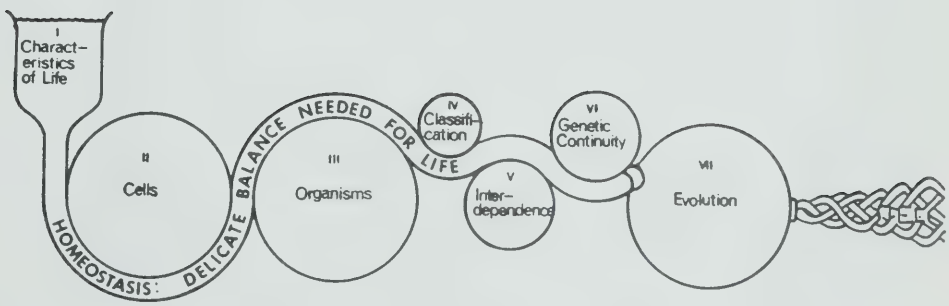
Part B

Curriculum Study Guide I

The Homeostatic Approach

This study guide illustrates one way that a teacher may choose to expand Part A of this publication directly. It leads to a teaching outline that is essentially the course introduced in 1965, together with the few changes which were contained in Curriculum S.8 (1966). All modifications have been designed to clarify the intent of the original course of study and to specify more exactly the depth of treatment intended.

This study guide is expected to appeal to the large number of teachers who have found the direct development of the theme satisfying. There is a logical sequence of topics, building new concepts upon the student's previous knowledge. Homeostasis, the delicate balance required to maintain life in the face of the fluctuating environment, is the unifying theme. This theme progresses logically from the cell through the organism to the community, and through the continuity of the species from one generation to the next to the evolutionary picture of life on this planet.



It is understood that this Guide offers suggestions for use at the teacher's discretion.

Unit I

Characteristics of Living Things

This unit is intended to organize the previously acquired knowledge of plants and animals to focus attention on those characteristics which make them living things.

1. Introduction

Examination of specimens and discussion from which students may prepare a list of the characteristics which distinguish living things from dead, dormant, and fossilized organisms and from inorganic matter.

2. Ways in Which Organisms Move

Observation of at least one living specimen to illustrate each of the following types of movement.

- Muscular movement with skeletal support: vertebrate, arthropod
- Muscular movement with no skeletal support: earthworm, hydra
- Ciliate and flagellate movement: paramecium, chlamydomonas, bacteria
- Distinction between locomotion (above) and motion as in eyelid, eye, tongue, heart
- Movements of higher plants: closing of leaves and flowers, growth movements

3. Ways in Which Organisms Respond to Stimuli

Observations of some of the responses of a living animal and a sensitive plant:

- Nature of stimuli: light, moisture, gravity, heat, cold, sound, touch, chemical substances
- Irritability of organisms without special sense organs
- Special receptors for stimuli: e.g., eye, ear, temperature receptors, pressure receptors, taste organs
- Mechanisms of conduction and response

4. Ways in Which Organisms Reproduce

Capacity for reproducing their kind:

- Asexual methods: vegetative methods or fission to include discussion of one of amoeba or hydra, one of plant bulbs, cuttings, bacteria or chlamydomonas, and one example of spore formation (mushrooms, mosses, or ferns)
- Sexual methods: fusion of gametes to produce a zygote from which the organism develops by growth, division, and differentiation of cells in both plants and animals

5. Ways in Which Organisms Maintain Themselves

A brief discussion of metabolism, its phases (anabolism and catabolism), and its processes: photosynthesis, digestion (extracellular, intracellular), assimilation, respiration, excretion.

Unit II

Cells

This unit emphasizes that the basic unit of life is the cell and that basic energy changes must proceed within it. The living protoplasm in all cells has similar physical and chemical properties. All cells are produced from preexisting cells.

1. Structure of Cells

- Student use of the microscope to see and review details of cell structure
- Examination of electron photomicrographs to see details of ultrastructure of cells
- Discussion of structure and functions of: nucleus, nucleoli, mitochondria, ribosomes, lysosomes, endoplasmic reticulum, Golgi body, ground substance, membranes, cell wall and pits, centrioles, vacuoles, plastids, starch bodies, fat bodies, protein bodies

2. Composition of Protoplasm

- Review of the structure of atoms of elements important in biology
- Molecules and chemical bonds, ionization
- Chemical reactions and the energy changes associated with them, equilibrium
- Enzymes as biological catalysts: laboratory exercise to illustrate organic molecules; functional groups important in organic reactions: hydroxyl, carboxyl, aldehyde, and amino
- Formation of carbohydrates, fats, and proteins: stress the general structure of the molecules indicating important linkages: ester, glucoside, and peptide. (Formulae should only be used where they illustrate linkages significant in biology.)
- Nucleic acids and nucleoproteins: brief reference to nucleotide bases and their linkage

3. Physical Properties of Protoplasm

- Include colloids, sol-gel changes
- Laboratory exercise to show coacervates and protoplasmic streaming

4. Catabolism

(a) Digestion: laboratory exercise to illustrate the hydrolysis of carbohydrates, fats, and proteins to produce simpler soluble substances (treatment as an essential preliminary to respiration)

(b) Respiration: the oxidation of the glucose molecule to carbon dioxide and water with energy made available in the reactions, laboratory exercises to illustrate

- Glycolysis: phosphorylation, splitting of the 6-carbon molecule to form pyruvate, a 3-carbon frag-

ment; formation of acetyl-coenzyme A; Krebs cycle for controlled release of energy by step-wise breakdown of molecules

- Transfer of energy by the ADP-ATP system, efficiency
- Metabolic role of vitamins and minerals
- Reference to the fact that after preliminary processing into 2-carbon fragments, fats and proteins may enter the same metabolic pathway as glucose
- Role of mitochondria

5. Anabolism

(a) Photosynthesis: laboratory exercise to show the relation of energy and chlorophyll to starch production, involvement of gases

- Energized chlorophyll: transfer of energy to the ADP-ATP system
- Light and dark reactions, formation of organic compounds
- The concept of available potential energy in the molecules
- Role of chloroplasts

(b) Other syntheses: brief treatment to show how simple organic compounds react to form cellulose and glycogen, how they can be converted into fatty acids and glycerol for fat synthesis, and how amino acids can be formed for protein synthesis.

6. Functions of Cell Membranes

Osmosis: laboratory exercise, cell turgor, permeability to substances other than water

- Active transport and its dependence on metabolic energy
- Importances of cell environment, composition of environment, limits of tolerance to changes in medium of cells, osmotic value, wilting
- Laboratory exercise to illustrate plasmolysis

7. Mitosis

- Laboratory exercise to study chromosome changes in growing cells
- Explanation of action of chromosomes and genes
- Self-replication of DNA and its relation to mitosis
- Regulation of metabolism, growth, and development
- Mechanism of virus action

Unit III

Organisms

In this unit the student becomes acquainted with the structures of a highly developed plant and an animal, both consisting of complex systems made up of organs, tissues, and cells. Emphasis is placed on the harmonious interaction of all the systems in maintaining homeostasis for the benefit of the entire organism. Similarities in essential activities are seen in plant and animal.

1. Organization of Differentiation of Cells

Meanings and examples of tissues, organs, and systems; problems of multicellular organization.

2. Dissection and Study of a Mammal

An examination of organ systems and some of the tissues composing them (epithelial muscle, connective, nerve, glandular); a discussion of the gross functions of these systems and tissues with attention to the fact that certain systems function to serve all cells of the body; integration of body functions

(a) Digestive system: mouth, esophagus, stomach, small and large intestines, digestive glands (names of enzymes and their specific actions not essential)

- Function: intake of food, extracellular digestion of food to components that can be used by cells, transfer of end products to blood and lymph for distribution

(b) Circulatory system: heart, arteries, arterioles, capillaries, venules, veins. Note that it is a closed system, that blood circulates, that arterial blood pressure is maintained, that no cell is very far from capillaries of this system (use living frog or fish to demonstrate).

- Block diagram of pulmonary and systemic circulation (names of arteries and veins not essential)
- Lymphatic system
- Function: transport of needed materials, including secretions of endocrine glands, to cells and of wastes away from cells

(c) Respiratory system: nasal passages, larynx, trachea, bronchi, bronchioles, lungs, alveoli, chest cavity, diaphragm, rib muscles, respiratory centre, and main respiratory nerves

- Function: ventilation of lungs, bringing fresh air close to capillaries, where oxygen enters blood for distribution to all cells and carbon dioxide carried from cells leaves blood.

(d) Elimination systems: kidney, glomerulus and capsule, tubules, ureter, bladder, urethra

- Function: filtration of blood, tubule reabsorption of water and useful solutes, elimination of waste solutes, regulation of water and solute content of body fluid which bathes body cells

• Elimination functions of sweat glands, respiratory system, digestive system; brief mention of function of sweat glands in regulation of body temperature and salt balance.

(e) Muscular and skeletal system: muscles, bones (names and descriptions of individual muscles and bones are not essential). Tissues: muscle and connective tissue, bone and cartilage

• Functions: movement, support, protection

(f) Reproductive system

• Male: structures, tissues (gonadal, glandular, muscular), functions

• Female: structures, tissues (gonadal, glandular, muscular, uterine epithelium), functions

(g) Co-ordinating systems

• Nervous system: brain (main parts), spinal cord, motor nerves, sensory nerves, mixed nerves, sense organs (details of structure of sense organs not essential except for the eye). Prepared dissections, rather than class dissections of the brain and spinal cord, could be used.

• Neurons: motor, sensory, connector; structure (cell body, axon, dendrite); reflex arc; associated connective tissue. Function: receiving information from environment and from all organs of the body and co-ordinating rapid response to conditions in environment and internal organs

• Student dissection of a mammalian eye and a study of the functions of its parts; relation of the optic nerve to the visual area of brain

• Endocrine system: complexly interrelated system of glands producing special substances (hormones) which are liberated into the blood and act on target organs. Hormones co-ordinate processes of metabolism, growth, and reproduction and regulate activity of organs which control water and salt content of body fluids. Names and locations of the endocrine glands, the hormones produced, their target organs and their functions

• Relation of nervous and endocrine systems

• Steady-state control of the whole organism: chemical control of breathing rate and depth; control of water balance, salt content, and glucose concentration of body fluids; control of the menstrual cycle in the human female. These control systems should be treated in sufficient detail that general principles of feedback systems will be made clear.

3. Dissection and Microscopic Examination of a Herbaceous Dicotyledonous Plant

Discussion of the following systems and their gross functions, showing that each system serves all the cells of the plant body; disucussion of other dicotyledonous plants to show features not illustrated by the example selected

(a) Supporting system: temporary (collenchyma tissue), permanent (sclerenchyma tissue, secondary wood), turgor, cell wall

(b) Anchoring system: roots, underground stems, diffuse or tap form of system, advantages of each, extent of root hair growth

(c) Absorbing system: root hairs and osmosis

• Water: water loss and osmotic values (transpiration)

• Ions: Accumulation and rejection of ions

(d) Conducting system: no cell in the plant is far from conducting cells

• Water and minerals: path from root hair to xylem of root, stem, leaves

• Sugars and amino acids: from site of photosynthesis through phloem of leaves, stem, roots, flower and fruit

(e) Growth system: nature and location of the primary meristems and their functions during elongation and differentiation

• Secondary meristems (vascular and cork cambiums) in roots and stems

(f) Gaseous exchange system: stomates and their operation, intercellular air spaces, wet cell walls, gaseous diffusion contrasted with breathing

(g) Photosynthetic system: favourable position of chlorophyll-bearing cells, each cell adjacent to an air space

(h) Food storage system: cells and structures specialized for storing energy in organic compounds: starch, fats, oils

(i) Reproductive system: flower, carpel, ovule, egg, anther, pollen grain, sperm, pollination, fertilization, seed, fruit

(j) Co-ordinating system: auxins operating through growth regions in roots and stems

• Abnormal growth due to disease organisms and parasites

• Initiation of flowering stage triggered by photoperiod and causing changes in the metabolism and growth pattern of the plant

• Effect of environmental factors on the seed development, germination, and growth

(k) Excretory system: waste accumulation in leaf, leaf fall, toxic substances exuded from roots

(l) Regulation of internal environment: plant starch-sugar balance and osmotic effects, water and salt balance, control of pH and temperature

Unit IV

Classification of Organisms

This unit provides a brief introduction to the purpose and principles of classification of organisms.

(a) Brief history of systematics: Linnaean system, present system

(b) Discussion of the principles involved in classification of organisms; meaning of species, genus, family, order, class, phylum, kingdom, as illustrated by the classification of a common example like the domestic cat

(c) Laboratory exercise: use of a simple dichotomous key to identify common Ontario conifers or other species of interest, plant or animal

Unit V

Interdependence of Organisms

This unit deals with organisms as mechanisms driven by energy which is derived from the sun and often stored in energy-rich foods by green plants. As well as energy, other interrelations lead to an appreciation of interdependence of organisms and their relation to the physical environment.

(a) Photosynthetic activity of chlorophyll-bearing plants producing energy-rich foods, carbohydrates, fats, proteins

- Dependence of fungi, bacteria, herbivores, carnivores, on energy stored in this food supply

(b) Food chains and food webs

- Carbon cycle, nitrogen cycle, cyclical use of other elements
- One-way flow of useful energy, pyramids of number, biomass energy

(c) Communities of organisms

- Succession in communities
- Interaction of organisms and environment

(d) Overproduction of offspring; number of spores, eggs, seeds, larvae or nymphs, juveniles, compared with number of adults in populations of insects, fish, trees, etc.

- Fluctuations in population density, natality versus mortality
- Biotic potential versus actual population

(e) Discussion of closely interdependent organisms such as parasites, saprophytes, symbionts, commensals, and social organisms, stressing the effects on each organism from the association; one example to illustrate each.

(f) Man as a dominant species, his dependence on other species, his effect on his environment, finite sources of energy, infinite potential to reproduce, problem of population size.

Unit VI

Heredity and Variation: Genetic Continuity

This unit describes the fundamental process providing the mechanism for continuance of life of each species by providing new individuals. Attention is to be focussed on the mechanism allowing for variations within populations and the importance of this for heredity and evolution.

(a) Duplication of an individual organism by asexual or sexual reproduction; asexual reproduction including the production of individuals whose inherited material (DNA) comes from a single parent with the chromosome number unchanged (vegetative reproduction) or with a reduction in the number of chromosomes by meiosis. In sexual reproduction the new individual develops from a zygote produced from the fusion of inherited material (DNA) contained in the gametes from two parents; sexual differentiation of gametes in many organisms

(b) Meiosis, variation in allele composition in gametes (e.g., egg and sperm); syngamy (fertilization), zygote, significance of these processes in transmission of genes (DNA) from generation to generation

- Mendelian inheritance
- Alternation of generations treated generally to show the occurrence of the haploid-diploid cycle in plants and animals, reference to the existence of tetraploids and polyploids
- Sex chromosomes, sex determined by a specific group of genes

(c) A general discussion of the start of life for an individual organism, cell enlargement producing growth, genetic control of these processes, importance of cell environment

- Spore, seed, and egg size in terms of stored energy for young organisms
- General discussion of the differences between plant and animal differentiation and growth, limited in plants to the development of the embryo in the seed, in ani-

mals to the development of the three primary germ layers of the gastrula

- Relative importance of sexual and asexual reproduction in maintaining populations of plants and animals, relation of numbers of offspring to parental care in maintaining population

Unit VII

Evolution: Changes in Living Things Through Time

This unit involves a study of the effects of heredity and of environmental changes on plants and animals.

(a) Darwin's theory of evolution based on evidence of fossils, plant and animal geography, and comparative gross morphology

(b) Variations in population of a species due to non-heritable environmental effects and due to heritable variation

- Recent ideas of mutation (change in DNA) as the source of change in heredity
- Selection of heritable variations due to environment and population pressure as a cause of evolution
- Conservative and divergent action of selection
- Genetic isolation and origin of species

(c) Source and development of domestic plants and animals, human selection in plant and animal breeding

Curriculum Study Guide II

An Ecological Approach

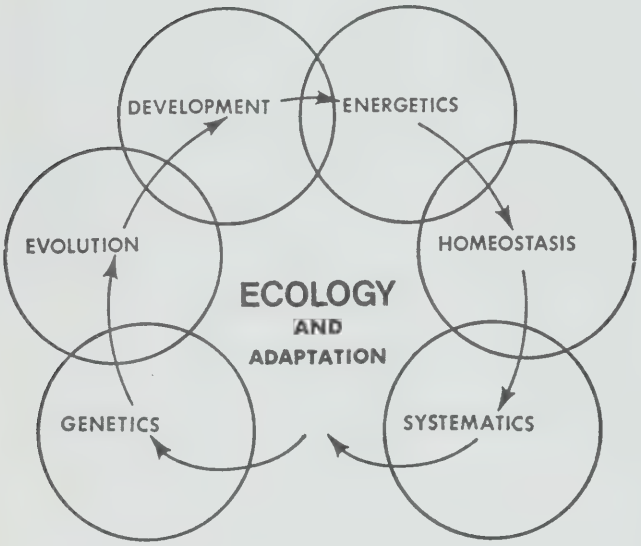
This study guide has been designed to encourage another thought-provoking, exciting approach to biology. It is organized around the study of whole organisms and their communities. Such a program will emphasize work in natural habitats along with the maintenance and study of laboratory populations. It will have a continual theme of relationship between organisms and the environment, both over long periods of time and at any particular instant.

The organization suggested here is based on this view as applied to the Course of Study. It will be noted that this approach provides an excellent opportunity for the discussion of most of the major problems facing mankind today. The ecological view provides an ideal framework for achieving that kind of biological education required by future citizens who will have to pass judgments on questions of energy utilization, proper use of land, pollution, and population.

It is understood that this Guide offers suggestions for use at the teacher's discretion.

A General Plan for an Ecological Approach

The starting point and unifying theme of this approach to biology is ecology. Six other areas of study have been incorporated into this program. Each one can be tied into the central theme by referring back to it in detail. A diagram is given below to help show an overview of the general plan. The idea of survival of an organism or of a species in its particular environment could be kept before the students at all times. It is a concept they can readily appreciate at this level of study and one which they will realize is vital to their existence.



Ecology and adaptation to the environment is the starting point, which leads into methods of adaptation involving genetics, including reference to mutations. Evolution can be thought of as a series of long-term adaptations, leading us to development from single cells to organisms, both on an evolutionary and embryonic scale. The organs and systems can be studied next, followed or accompanied by a consideration of the energy relationships within the body at a molecular level. The study of homeostatic mechanisms on a molecular and community basis follows. The diverse ways in which homeostasis is brought about with respect to the environment and adaptation to a particular community has forced scientists to devise systems of classification.

The sequence of units has been designed so that each can lead logically to the next and provide the necessary background for succeeding work. It is expected that constant referral to preceding ideas will unify the course as a story-line develops. Referrals ahead will be inevitable but would be best kept to an introductory and anticipatory nature in order that the main theme will not be lost through lengthy digression.

How to Use This Guide

The succeeding pages have been set up for easy cross-reference. Each column has a special use which is explained below.

Intent. This column sets out the broad aims and objectives for each section of the work. These are, of course, more far-reaching than just the acquisition of facts. Many ideas in this column are applicable throughout the entire program but have been placed where they seem particularly appropriate. The teacher should use these over-all concepts and objectives in order to maintain the perspective of the course.

Suggested activities. These activities may be useful in planning each section, are in keeping with the intent, and should be of interest to students. Space is provided so that the teacher may add to this column other appropriate activities.

Course of Study references. These items refer back to the Course of Study and are provided to show the relationship of the ecological approach to the Course of Study. Each reference is placed opposite the appropriate items in the other columns.

Possible laboratory investigations. These provide ideas for student experimentation. Students are encouraged to try a variety of methods to solve the problems posed in this course including methods which they themselves design. When students participate, they will better appreciate the activities of scientists. Such investigations will take more time and thus will reduce the amount of material completed in one year of biology. The teacher must decide the relative importance of active student participation in the scientific process compared to the acquisition of facts and concepts through other means. The letters at the top refer to authors of laboratory manuals, and the numbers are page references. In some cases (preceded by #) the number refers to a particular experiment or pamphlet. Where two numbers are joined by a hyphen (7-20) the reader is referred to material found between those two page numbers. A key to this column is provided. Each investigation provides a starting point from which to try different experiments. The teacher is encouraged to refine, to delete, and to add to the list.

Special resource materials. Execution of a well-rounded biology program requires a well-stocked library of

reference materials as well as other resources as indicated. The materials listed have been selected as particularly suitable for the designated topic. A list of general reference books can be found at the end of this publication.

Key to Laboratory Manuals

Bfo- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Follansbee, H. *A Laboratory Block. Animal Behavior*. Boston, D. C. Heath, 1965 (Toronto, Copp Clark)

Bgl- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Glass, B. *A Laboratory Block. Genetic Continuity*. Boston, D. C. Heath, 1965 (Toronto, Copp Clark)

Bja- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Jacobs, W. P., and La Motte, C. E. *A Laboratory Block. Regulation in Plants by Hormones: A Study in Experimental Design*. Boston, D. C. Heath, 1964 (Toronto, Copp Clark)

Ble- American Institute of Biological Sciences, Biological Sciences Curriculum Study. Lee, A. E. *A Laboratory Block. Plant Growth and Development*. Boston, D. C. Heath, 1963 (Toronto, Copp Clark)

Bmo- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Moog, F. *A Laboratory Block. Animal Growth and Development*. Boston, D. C. Heath, 1963 (Toronto, Copp Clark)

Bph- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Phillips, E. A. *A Laboratory Block. Field Ecology*. Boston, D. C. Heath, 1964 (Toronto, Copp Clark)

Bpr- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Pramer, D. *A Laboratory Block. Life in the Soil*. Boston, D. C. Heath, 1965 (Toronto, Copp Clark)

Bri- American Institute of Biological Sciences. Biological Sciences Curriculum Study. Richards, A. G. *A Laboratory Block. The Complementarity of Structure and Function*. Boston, D. C. Heath, 1963 (Toronto, Copp Clark)

Bg- The Regents of the University of Colorado. Biological Sciences Curriculum Study. *Student's Manual. High School Biology (BSCS Green Version)*. 2d ed. Chicago, Rand McNally, 1968 (Scarborough, W. J. Gage)
Note: This Student's Manual is part of the textbook.

By- American Institute of Biological Sciences. Biological Sciences Curriculum Study. *Student Laboratory Guide. Biological Science: An Inquiry Into Life (BSCS Yellow Version)*. New York, Harcourt, Brace & World, 1963 (Don Mills, Longmans)

Buc- Buchsbaum, R. *Animals Without Backbones*. Revised ed. Chicago, University of Chicago Press, 1948

Dem- Demerec, M., and Kaufmann, B. P. *Drosophila Guide*. 7th ed. Washington, D.C. (1530 P Street NW), Carnegie Institute of Washington, 1961

Fie- Field, H. E., and Taylor, M. E. *An Atlas of Cat Anatomy*. Chicago, University of Chicago Press, 1950.

Gal- Galbraith, D. I. *Lab Manual. Biological Science: Principals and Patterns of Life*. Toronto, Holt, Rinehart & Winston, 1968

Law- Lawson, C. A. *Laboratory and Field Studies in Biology*. Teacher's edition. New York, Holt, Rinehart & Winston, 1960 (Toronto, Holt, Rinehart & Winston)

Mor- Morholt, E., and others. *Teaching High School Science: A Sourcebook for the Biological Sciences*. 2nd ed. New York, Harcourt, Brace & World, 1966 (Don Mills, Longmans)

Row- Rowett, H. G. Q. *Dissection Guides*. 5 volumes. New York, Holt, Rinehart & Winston, 1957 (Toronto, Holt, Rinehart & Winston)

Spe- Speed, F. M. *Laboratory Manual. New Biology*. Toronto, Ryerson Press, 1965

Tur- *Turtox Service Leaflets*. Chicago (South Hayne Avenue), General Biological Supply House

Wal- Wald, G., and others. *Twenty-six Afternoons of Biology: An Introductory Laboratory Manual*. Reading, Mass., Addison-Wesley, 1962 (Don Mills, Addison-Wesley)

War- *Ward's Curriculum Aids and Culture Leaflets*. Rochester, N.Y., Ward's Natural Science Establishment (Port Credit, Arbor Scientific)

Wit- Witherspoon, J. D. and R. H. *The Living Laboratory*. New York, Doubleday, 1960 (Toronto, Doubleday)

Ecology

Intent

To stimulate thought and interest along biological lines

To recall organisms studied in earlier grades and to appreciate the great variety of living things and their activities

To become familiar with the techniques of examination of specimens and the use of the microscope

Suggested Activities

Direct observation of living materials; dissection of lower organisms

Students could design and carry out simple experiments.
(Suggestions on page 17 are intended to assist the teacher in the selection of appropriate materials.)

Course of Study Reference	Possible Laboratory Investigations								Special Resource Materials
Unit I	Law	Bri	By	Wal	Bfo	Spe	War	Gal	
Characteristics of Living Things	96 295		146	8			#1		It is intended that this work be primarily practical. Some background reading might include:
1. Movement Skeletal	29	31 33	165 166						
Non-skeletal Protozoan	26 33 228 258	49 59 61	25 151	11		8 12	#3 #4		Hocking, *The Ultimate Science* Asimov, *Biology*
Plants	226 285		103 141						Buchsbaum, *Animals Without Backbones*
2. Irritability Protozoan	230 258		157 162 191	9	6 8 9 11				*The Single-celled Animals: Protozoa. Stinging-celled Animals: Coelenterates*, E.B. Films
Higher organisms	308 155 162 262 29 33		192		12 14 15 16 17 34 36				
3. Reproduction	310 313 314		159 166	7					
4. Metabolism			153 155	9 11			#2 #6	#31	

Intent

To stress the interaction of organisms with their environment and with other organisms

To develop ability involving valid experimental techniques, observations, and conclusions, both in the laboratory and in the field

Suggested Activities

Thorough analysis of environmental factors affecting the local plant and animal communities; controlled laboratory experimentation

The study of environmental conditions and adaptations in other biomes

Course of Study Reference	Possible Laboratory Investigations							Special Resource Materials
Unit V	Law	Tur	Gal	By	Bg	Bpr	Bph	
3. Communities	396							*The Community, Distribution of*
2. Food chains and webs	434		1	66 267	125 135	51 46	58-60	*Plants and Animals, The High Arctic Biome, The Desert,*
Cycles	3			271	142 155		37-44	*The Physical Environment,* E.B. Films
	8 22 24 400 412							
	Law	Tur	Gal	By	Bg	Bpr	Ble	
3. Succession; interaction with the environment	281	30	#2	3	57 58 171 129	51	7-20	*Succession: From Sand Dune to Forest,* E.B. Films
	404 406 410	51			138 173 148			
5. Interdependence of organisms	418-431				122			
	317				125			

Intent

To develop an awareness of the social implications of biological problems

To become an informed citizen, capable of intelligent discussion

To encourage the efficient use of resource materials wherever available

Suggested Activities

The collection, preparation, and presentation, in seminar form, of information regarding pertinent problems facing man today, could include such topics as the shortage of food, overcrowding, disease, air and water pollution. These should be related to the population dynamics of other organisms.

Course of Study Reference	Possible Laboratory Investigations						Special Resource Materials
Unit V (continued)	Law	Gal	Bg	By	Bmo	Bfo	
4. Population dynamics (fluctuations, potential, structure, parental care)	20 406 415 475	text 511	116 364 368 6		50-54	52	Odum, *Ecology* Bio Science Scientific American Fortune Time
6. Man's population problems and effect on environment. Dependence on other species. Sources of energy	210 444 448 281						*The Rival World*, *The Living Soil*, *Food or Famine*, *The River Must Live*, Shell Films
	Law	Tur	Gal	By	Bg	Bph	
Population pressures. Natural and artificial selection related to adaptation	479	511		443 251 225	 334 339 348	 58	*Population Ecology*, *Natural Selection*, E.B. Films
Unit VII							
3. Improvement of domestic plants and animals							

Genetics

Intent

To understand the mechanisms of heredity and adaptation

To develop an appreciation of the historical background of genetic theory

To be able to recognize the significance of meiosis and mitosis in a variety of specimens

To initiate in the student the ability to record accurately, pertinent data presented by others

To realize both the usefulness and the limitations involved in the use of visual and conceptual models to illustrate a concept

Suggested Activities

The examination and interpretation of microscope slides; the use of films and filmstrips

The use of models, etc. to demonstrate the process of mutation, the structure of DNA, the replication of DNA, and the action of RNA

The recording, organization, and analysis of notes taken during the presentation of material by the teacher

An appraisal of current materials in newspapers and periodicals

Course of Study Reference	Possible Laboratory Investigations								Special Resource Materials
Unit VI	Law	By	Dem	Wal	Gal	Bgl	Bg	Bpr	
1. Reproduction: asexual, sexual, gamete and zygote formation									*Mitosis*, E.B. Films
Mitosis	331	64			18		22		
Meiosis	333	64					44		
DNA-RNA	239						104		Levine, *Genetics*
Patterns of heredity	329	213	all	123			61	340	
	335	221					68		
	339						87		Wallace and Dobzhansky,
	348						92		*Radiation, Genes, and Man*
							111		
Variation: heritable,					Tur				
non-heritable.	322	231					98		
Mutations		241	all	41-50	#53		24	294	
						131		58	

Evolution

Intent

To introduce the student to the development of evolutionary thought down through the ages to the present day, and the material evidence upon which this thought was based

To make the student aware of the tremendous observational and analytical abilities of men such as Wallace and Darwin

To be sure that the student understands that the mutation takes place before the selection

To encourage an open-minded approach to scientific thought

To develop an awareness of the unique position of man, and his potential in the control of his environment

Suggested Activities

The use of the seminar is suggested as an approach to this topic

The study of the mechanisms (including the isolating mechanisms) of natural selection and the pressures that force a population to exploit every possible niche

Course of Study Reference	Possible Laboratory Investigations					Special Resource Materials
Unit VII	Gal	Bgl	Law	Bg	Bpr	
2. Mechanism of evolution; role of mutations	#7	6-13	455 471	342 190-198		
Selection			473	364		
Speciation			377	368		*Darwin and the Insects of Brazil*, Shell Films
1. Darwin's theory and evidence including embryological comparisons						*Darwin and the Galapagos*, CBC Publications

Development

Intent

To develop an appreciation of the fact that the cell is the basic unit of life, and to compare and contrast plant and animal cells

To note the effects of the external modifiers of gene action

To understand the development of tissues and organs from the unicellular to the multicellular organism

To recognize the various tissues and organs in plants and animals

Suggested Activities

The recall of the structure and function of DNA, RNA, coding, etc.

The observation of the environmental conditions modifying the development of the egg and the larvae

The developmental background of selected systems should be discussed briefly from the "amoeba to man." It is felt that this will lead to a better understanding of each system and of their interaction and interdependence. A similar comparison could be carried out in the study of the plant. Reference can be made to adaptation and homeostasis.

Course of Study Reference	Possible Laboratory Investigations								Special Resource Materials
Unit VI	Spe	Law	War	Tur	Ble	Bg	By	Bmo	
Embryological development	18	230	#7	#17	1-7	275		1-46	*The Fish Embryo*, *Amphibian Embryo*, *The Chick Embryo*, E.B. Films
						288	201-208	58-74	
Genetic and environmental control					31-38 55				
	Gal	Law	Bg						
Growth	#26	151	231						
Unit III									
1. Cells, tissues, organs, systems		293 379 388 390 392							

Intent

To develop sound techniques of dissection and observation

To produce drawings and/or functional schematic diagrams from reality

Suggested Activities

The dissection of a plant and an animal

Course of Study Reference	Possible Laboratory Investigations								Special Resource Materials
Unit III (continued)									
2. Dissection and study of a mammal									
(a) Mechanics of digestion	Spe	Fie	Row	Gal	Wal	Bg	Law	By	
(b) Circulation		19-21		24-27	89	247	202-208	174-184	
		Tur	Wit	41	78	257			
		42	183-214	42		267	214 217		
(c) Mechanics of respiration		Bri 50-53	219-236		78		219	121 123	
(d) Mechanics of excretion		34		22 30	84	220	129	Bph 62	

Please Note: The energetics of metabolism and transport will be considered in the next section, as will

bonding, which was not covered under the DNA-RNA system.

You may find it more reasonable to combine the two sections on Development and Energetics in order that structure and function may be more closely related.

Course of Study Reference	Possible Laboratory Investigations									Special Resource Materials
Unit III (continued)	Law	Gal	Spe	By	War	Bri	Wal			
2. (e) Support and movement	224 243-257	32	21	195	Skele-tons	13-30	107			
(f) Reproduction	Bgl		Bmo			Bg	Tur			
	25-29	38	35	131 201 209	115-132	269 284	16			
(g) Nerves	Law		Spe		Wit	Bri	Wal			
	266 271	34	27 50 24-26	195	95-105 153	63-70	99			*Fundamentals of the Nervous System*, E.B. Films
3. Support in plants and conduction	Bri	Tur 9	Ble	Gal 28	Wal 82	Bg 234	Law 221	By 125	Bph	
	34		39-41	29 33	86			127 130	66	

Energetics

Intent

To develop an understanding of the basic role of energy in all phases in the life of the organism, including the capture, transfer, and use of energy in its various forms, with regard to both the individual organism and the biosphere

To appreciate the advanced yet conflicting theories concerning the metabolic pathways and transport of materials

Suggested Activities

The examination of living cells, microscope slides, visual models, and electron micrographs

Experiments to investigate the properties and functions of the cell membrane, with particular emphasis on the energetics

The construction of molecular models in order to promote an understanding of the composition and physical properties of protoplasm and the energetics of bonding

The development of a description of the major metabolic processes, stressing the non-cyclic nature of energy as opposed to the cyclic nature of some organic materials

Course of Study Reference	Possible Laboratory Investigations									Special Resource Materials
Unit II	Law		Gal	Spe	By.		Bg	Wal		
1. Structure of cells when necessary	70	80	13-17	28	45		205	7		
	85	94		29	23		207	22		
	99		3		49		82			
2. Composition of protoplasm	102		4		51					
3. Physical properties of protoplasm	116		23		130					
6. Movement across membranes	123									
	172									
	174									
	179									
	181									
5. Photosynthesis (Unit III, 3(g))						Ble		War	Bph	*Photosynthesis*,
	105		11	33	117	49-54	217	57	17	E. B. Films
	111		12		115		228	119		66
	127				119					
	131									
	133									
	143									

Intent

To learn to set up a hypothesis and to test it experimentally

Course of Study Reference	Possible Laboratory Investigations								Special Resource Materials
Unit II (continued)									
4. Digestion and enzymes	Law	Tur	Bg	Wal	Spe	By	Bpr	Gal	
	134	49	245	13	22	153	54	19	
	188-195		260	26	16	177		20	
			213	34	17	53-61		5	
				43		91			
		Ble					Wit		
Respiration	137-143	45-48	223	62	32	94	159-165	21	
	147					95			
	149					185			
	153								
		Bri							
ATP	127	66			14-15			9	

Homeostasis

Intent

To develop an understanding of the importance of cellular environment, and the very strict maintenance of the content and quality, as a matter of survival

To appreciate the universality of homeostasis, from the individual to the biosphere

To acquire experience in the setting up of well-controlled experiments and in the analysis of the results

Suggested Activities

Experiments to investigate regulatory mechanisms within the organism which maintain constancy of internal environment

The discussion of homeostasis at the various levels: the individual, the population, the community, and the biome

Experiments to determine the effect of auxins on plant development and to relate these factors to external influences

Course of Study Reference	Possible Laboratory Investigations									Special Resource Materials
Unit III	Law	Bri	Bg	Wal	Bgl	By	Bfo	Gal		
2. (g) and all other systems where applicable	155 162 206 219	54 29	288	90	124	187 195 197 199	15-20 54	26		Overmire, *Homeostatic Regulation*
Refer to all work in Unit I, 2	318									
				Bmo	Ble		Gal	Bja	Bpr	
3. (c), (e), (f), (j)	158 285-294 388 390 392	54	225 263	8	59-67	143 70	36 35	all	58	
Unit V Refer back	20-25									

Systematics

Intent

To understand the importance and use of diversity among living things as a means of survival in variable environments

To appreciate the need for a universal system of classification and nomenclature

To understand the mechanics of classification

To appreciate the reasons behind the artificial and the natural systems of classification, and the importance of genetics to modern phylogenetic systems

Suggested Activities

The use of field trips to observe the great variety in living things and to show how these are adapted for survival

A discussion of the historical aspects of classification and some of the men involved, such as Ray, Linnaeus, etc.

The construction and use of the dichotomous key

A discussion of modern techniques used in classification, and the genetic aspects

Please Note: This may well be a good point upon which to complete the full circle of the ecological approach and to stress the fact that all organisms, including man, must be able to adapt to change in order to survive.

This is the homeostatic process on both the cellular and the population level, involving not only genetic variation from one generation to the next, but also continuous protoplasmic adjustment and perhaps even cultural adjustment in the case of man himself.

Course of Study Reference — **Possible Laboratory Investigations** — **Special Resource Materials**

Refer back to:
Unit I, the variety of organisms and their ways of functioning.
Refer to Unit VII, 2, Natural Selection and Speciation.

Unit IV	Bpr	Tur	Gal	War	Spe	Bg	By
2. Principles of classification	18	#1 #2 #3 #6	#37	#3 #5 Plant	37-48	65-98 132	99 133 173
3. Selected items to suit the needs of the student in understanding and applying this work		#24 #33 #41					

Curriculum Study Guide III

A Principles Approach

Every biology teacher will be aware that biology, with all its diversity of detail and presentation, converges into a few broad, general pathways determined by the experiences and sequence of learning events in the life of each individual. With this in mind, one can understand the philosophy of this approach. The outline given in this Study Guide represents one style of thinking. If the principles are chosen carefully, the areas of learning in biology will relate all the principles in a multitude of ways. These relationships will become more and more evident as time brings increasing richness of experience. It is therefore suggested that the teacher attempting this approach consider the arrangement of the subject matter under the principles as outlined. If he can see groupings more to his liking, he should follow his own arrangement. Some students, with the fresh approach of youth, may see more appealing ways of grouping the materials studied and be stimulated to form their own relationships among these major biological principles.

Note: No reference has been made to dissections in the re-arrangement of the units and topics under the seven principles. Since many or all the principles are involved in Unit III of the Course of Study, which includes dissections, and since each teacher will have his own emphasis, the arrangement of this subject matter has been left to the teacher.

The seven principles on which this approach is based are as follows:

1. Living things have characteristics which set them apart from non-living things.
2. In a study of living things, hierarchies can be organized.
3. Energy runs a one-way course through the web of life.
4. The reactions occurring in living organisms tend toward equilibrium.
5. Living things are dependent on each other and on their environment.
6. Heredity and environment determine the nature of the individual.
7. Animals and plants are in constant change.

An attempt has been made on the following pages to arrange the subject matter indicated by the Course of Study in support of these principles.

It is understood that this Guide offers suggestions for use at the teacher's discretion.

Principle 1

Living Things Have Characteristics Which Set Them Apart from Non-living Things

Examination of specimens and discussion, from which students may prepare a list of the characteristics which distinguish living things from dead, fossilized organisms and from inorganic matter.

Ways in Which Organisms Move

Observation of at least one living specimen to illustrate each of the different types of movement:

- Muscular movement with skeletal support: vertebrate, arthropod
- Muscular movement with no skeletal support: earthworm, hydra
- Ciliate and flagellate movement: paramecium, chlamydomonas, bacteria
- Distinction between locomotion and motion as in eyelid, eye, tongue, heart
- Movements in higher plants: closing of leaves and flowers, growth movements.

Ways in Which Organisms Respond to Stimuli

Observations of some of the responses of a living animal and a sensitive plant:

- Nature of stimuli: light, moisture, gravity, temperature, sound, touch, chemical substances
- Irritability of organisms without special sense organs: plants, protists
- Special receptors for stimuli: eye, ear, temperature receptors, pressure receptors, taste buds
- Mechanisms of conduction and response.

Ways in Which Organisms Reproduce

Capacity for reproducing their kind

- Asexual: vegetative or fission: one of amoeba or hydra, and one of plant bulbs, plant cutting, bacteria, chlamydomonas
  : spore production: one of mushroom, mosses, or ferns
- Sexual: fusion of gametes to produce zygote from which the organism develops by growth; division and differentiation of cells in both plants and animals; study of mitosis to explain growth

Ways in Which Organisms Maintain Themselves

Metabolism: a brief discussion of anabolism, catabolism, and the processes involved; namely, photosynthesis, digestion (extracellular, intracellular), assimilation, respiration, excretion

Principle 2

In a Study of Living Things, Hierarchies Can Be Organized

One example of a hierarchy is: atoms, molecules, organelles, cells, tissues, organs, systems, individuals, communities.

Composition of Protoplasm

- Review of structures of atoms, molecules, ions, chemical bonds, important in biology in relation to protoplasm.
- Organic molecules: functional groups important in organic reactions: hydroxyl, carboxyl, aldehyde, and amino
- Formation of carbohydrates, fats, and proteins: stress the general structure of the molecules indicating important linkages: ester, glucoside, and peptide. (Formulas should be used only where they indicate linkages significant in biology.)
- Nucleic acids and nucleoproteins: brief reference to nucleotide bases and their linkages

Physical Properties of Protoplasm

- Laboratory exercises to show coacervates and protoplasmic streaming
- Discussion of colloids, sol-gel changes

Structure of Cells

- Student use of the microscope to see and review details of cell structure
- Examination of electron photomicrographs to see ultrastructure
- Discussion of structure and function of: nucleus, nucleoli, cytoplasm, mitochondria, ribosomes, lysosomes, endoplasmic reticulum, Golgi body, ground substance, membranes, cell wall and pits, centrioles, vacuoles, plastids, starch bodies, fat bodies, protein bodies

Organization and Differentiation of Cells

- Meanings and examples of tissues, organs, and systems
- Problems of multicellular organization up to the organism level

Groupings of Organisms or Individuals

- Brief reference to the part played by the organism or individual as related to populations, communities

Another example of a hierarchy is: species, genus, family, order, class, phylum, kingdom.

Classification of Organisms

- Brief history of systematics: Linnaean system, present system
- Discussion of the principles involved in the classification of organisms; meaning of species, genus,

family, order, class, phylum, kingdom, as illustrated by the classification of a common example like the domestic cat

- Laboratory exercise: use of a simple dichotomous key to identify common Ontario conifers or other species of interest, plant or animal

Principle 3

Energy Runs a One-way Course Through the Web of Life

Chemical Reactions

- Recognition that in chemical reactions there are energy changes
- Enzymes as biological catalysts: laboratory exercises to illustrate

Energy Relationships in the Organism

Anabolism

- Photosynthesis: laboratory exercises to show the relation of energy and chlorophyll to starch production; involvement of gases
- Energized chlorophyll: transfer of energy to the ADP-ATP system, light and dark reactions, formation of organic compounds, the concept of the available potential energy in the molecules, role of chloroplasts
- Other syntheses: brief treatment to show how simple organic compounds react to form cellulose and glycogen, how they can be converted into fatty acids and glycerol for fat synthesis, and how amino acids can be formed for protein synthesis

Catabolism

- Digestion: laboratory exercise to illustrate the hydrolysis of fats, carbohydrates, and proteins to produce simpler soluble substances (treatment as an essential preliminary to respiration)
- Respiration: the oxidation of the glucose molecule to carbon dioxide and water with energy made available in the reactions, laboratory exercises to illustrate
- Glycolysis: phosphorylation, splitting of the 6-carbon molecule to form pyruvate, a 3-carbon fragment; formation of acetyl-coenzyme A; Krebs cycle for controlled release of energy by step-wise breakdown of the molecules
- Transfer of energy via the ADP-ATP system, efficiency of transformations, metabolic role of vitamins and minerals
- Reference to the fact that after preliminary processing into 2-carbon fragments, fats and proteins may enter the same metabolic pathway as glucose
- Role of mitochondria

Energy Relationships in the Community

- Food chains and food webs
- Carbon cycle, nitrogen cycle, cyclical use of other elements
- One-way flow of useful energy
- Pyramids of numbers, biomass energy

Principle 4

The Reactions Occurring in Living Organisms Tend Toward Equilibrium

A review and extension of energy changes associated with chemical reactions (principle 3) to include equilibrium

Functions of the Cell Membranes

- Emphasis in this study should be on the role of the cell membrane in relation to equilibrium
- Osmosis: laboratory exercises, cell turgor, permeability to substances other than water, active transport and its dependence on metabolic energy
- Importance of cell environment, composition of environment, limits of tolerance to changes in medium of cells, osmotic value, wilting, laboratory exercise to illustrate plasmolysis

Endocrine System

- Complexly related system of glands producing special substances (hormones) which are liberated into blood and carried to target organs on which they act
- Co-ordination by hormones of processes of metabolism, growth, and reproduction and regulation of activity of organs which control water and salt content of body fluids
- Names and locations of the endocrine glands, the hormones produced, their target organs, and their functions
- Interrelations of nervous and endocrine systems
- Hormonal regulation of plant activity

Steady-state Control of the Whole Organism

- Chemical control of breathing rate and depth
- Control of water balance, salt balance, and glucose concentration of body fluids
- Control of the menstrual cycle in the human female

These control systems should be treated in sufficient detail that the general principles of feedback systems will be made clear.

- Plant starch-sugar balance and osmotic effects; control of pH and temperature

Principle 5

Living Things Are Dependent on Each Other and on Their Environment

This unit deals with organisms as mechanisms driven by energy derived from the sun and often stored in energy-

rich foods by green plants. As well as energy, other relationships lead to an appreciation of interdependence of organisms and their relation to the physical environment.

Storage of Solar Energy in Organisms

- Photosynthetic activity of chlorophyll-bearing plants producing energy-rich foods, carbohydrates, fats, proteins
- Dependence of fungi, bacteria, herbivores, carnivores, on energy stored in this food supply

Factors Affecting Populations

- Relative importance of sexual and asexual reproduction
- Numbers of spores, eggs, seeds, larvae or nymphs, juveniles, as compared with adults in populations of insects, fish, trees, etc.
- Parental care
- Fluctuations in population density – natality versus mortality, biotic potential versus actual population

Communities of Organisms

- Succession in communities
- Interactions of organisms and environment

Plant-Animal Interrelationships

Discussion of closely interdependent organisms such as parasites, saprophytes, symbionts, commensals, and social organisms, stressing the effects on each organism from the association; one example to illustrate each.

Relationship of Man to the Environment

- Man as a dominant species
- His dependence on other species
- His effect on his environment
- Finite sources of energy
- Infinite potential to reproduce
- Problems of population size

Effects of Environment on Behaviour

Factors which control behaviour: size of territory, age, cover, temperature, food, sex, population density, and others. (This affords students a wide variety of topics for independent investigation.)

Principle 6

Heredity and Environment Determine the Nature of the Individual

This unit describes the fundamental process providing the mechanism for continuance of life of each species by providing new individuals. Attention is to be focused on the mechanism allowing for variations within populations and the importance of this for heredity and evolution.

Duplication of an Individual Organism

- Asexual (vegetative) and sexual reproduction
- Reference to chromosome number and inherited material (DNA)
- Sexual differentiation of gametes in many organisms

Heredity and Variation: Genetic Continuity

- Meiosis, variation in allele composition in gametes
- Syngamy, zygote, significance of these processes in the transmission of genes from generation to generation
- Mendelian inheritance
- Alternation of generations, treated generally to show the occurrence of the haploid-diploid cycle in plants and animals
- Reference to the existence of tetraploids and polyploids
- Sex chromosomes; sex determined by a specific group of genes

Development

- A general discussion of the start of life for an individual organism, cell enlargement producing growth, genetic control of these processes, importance of cell environment
- Spore, seed, and egg size in terms of stored energy for young organisms
- General discussion of the difference between plant and animal differentiation and growth, limited for plants to development of the embryo in the seed, in animals to the development of the three primary germ layers of the gastrula

Principle 7

Animals and Plants are in Constant Change

Darwin's Contribution to the Theory of Evolution

Evidence based on plant and animal geography, comparative gross morphology, and fossils

Variations in Populations of Species

- As affected by non-heritable environmental factors
- As affected by heritable variation
- Recent ideas of mutations (change in DNA) as the source of change in heredity
- Selection of heritable variation due to environment; population pressure as a cause of evolution
- Convergent and divergent action of selection
- Genetic isolation and origin of species

Man's Contribution to Change

- Source and development of domestic plants and animals
- Selection by man in plant and animal breeding

Part C
Book List

There is a large number of books useful for class work, student reference, teacher reference, or just plain reading in biology. Some of these books are listed here in rough groupings by subject or use. Several publishers offer series of books in which some titles are better for our purposes than others. Nevertheless, to prevent duplication, the subject lists which follow contain no books that are parts of series. The various series are listed separately.

General Biology

American Institute of Biological Sciences. Biological Sciences Curriculum Study. (Schwab, J. J., supervisor.) *Biology Teachers' Handbook*. New York, John Wiley & Sons, 1963 (Don Mills, General Publishing)

Baker, J. J. W., and Allen, G. E. *Matter, Energy, and Life: An Introduction for Biology Students*. Reading, Mass., Addison-Wesley, 1965 (Don Mills, Addison-Wesley)

Baker, J. J. W., and Allen, G. E. *The Study of Biology*. Reading, Mass., Addison-Wesley, 1967 (Don Mills, Addison-Wesley)

Barker, W. B., and Springthorpe, G. G. *A Concise Biology*. London, England, Longmans, Green, 1963 (Don Mills, Longmans)

Dobzhansky, T. *Evolution, Genetics, and Man*. New York, John Wiley & Sons, 1955 (Don Mills, General Publishing)

Cockrum, L., and others. *Biology*. Philadelphia, W. B. Saunders, 1966 (Toronto, W. B. Saunders)

Galbraith, D. I., and Wilson, D. G. *Biological Science: Principles and Patterns of Life*. Revised ed. Toronto, Holt, Rinehart & Winston, 1966

Gregory, W. H., and Goldman, E. H. *Biological Science for High School*. Boston, Ginn, 1965 (Toronto, Ginn)

Kimball, J. W. *Biology*. Reading, Mass., Addison-Wesley, 1965 (Don Mills, Addison-Wesley)

Mavor, J. W., and Manner, H. W. *General Biology*. 6th ed. New York, Macmillan, 1966 (Galt, Collier-Macmillan)

Miller, D. F., and Vance, B. B. *Science of Biology: Laboratory and Field Investigations*. Philadelphia, Lippincott, 1966 (Toronto, McClelland & Stewart)

New York City Board of Education. Bureau of Curriculum Research. *Adventures in Biology*. 1961

Otto, J. H., and Towle, A. *Modern Biology*. New York, Holt, Rinehart & Winston, 1965 (Toronto, Holt, Rinehart & Winston)

Penny, D., and Waern, R. *Biology*. Toronto, Sir Isaac Pitman, 1965

The Regents of the University of Colorado. Biological Sciences Curriculum Study. *Biological Science: An Inquiry Into Life* (*BSCS Yellow Version*). 2d ed. New York, Harcourt, Brace & World, 1968 (Don Mills, Longmans)

The Regents of the University of Colorado. Biological Sciences Curriculum Study. *Biological Science: Molecules to Man* (*BSCS Blue Version*). Revised ed. Boston, Houghton Mifflin, 1968 (Don Mills, Thomas Nelson & Sons)

The Regents of the University of Colorado. Biological Sciences Curriculum Study. *High School Biology* (*BSCS Green Version*). 2d ed. Chicago, Rand McNally, 1968 (Scarborough, W. J. Gage)

Simpson, G. G., and Beck, W. S. *Life: An Introduction to Biology*. 2d ed. New York, Harcourt, Brace & World, 1965 (Don Mills, Longmans)

Smallwood, W. R., and Green, E. R. *Biology*. Morristown, N.J., Silver Burdett, 1968 (Scarborough, W. J. Gage)

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